CLAIMS

What is claimed is:

1. A switch-mode power converter for converting an input voltage from an input source to an output voltage for supply to a load, the power converter comprising:

a power isolation transformer having a primary winding and split first and second secondary windings;

a primary converter circuit employing full bridge topography comprising a first, and a second primary controllable power switch forming one leg of said full-bridge and a third and a fourth primary controllable power switch forming a second leg of said full-bridge, said first and said fourth primary controllable power switch being connected to the positive side of the input voltage and said second and said third primary controllable power switch being connected to negative side of input voltage, each said leg of said full bridge being connected to said primary winding of said power transformer for alternatively supplying the input voltage to said primary winding of said power isolation transformer to produce a substantially symmetrical current in said primary winding;

a full wave secondary converter circuit fully isolated from said primary converter circuit and comprising first and a second synchronous rectifiers, said synchronous rectifiers being individually switchable and each being connected between a respective one of said first and second secondary windings and the load;

a first, a second, a third and a fourth primary switch control circuit controlling the conduction of said first, second, third and fourth primary controllable power switches;

a synchronous rectifier control circuit controlling conduction of said each first and second synchronous rectifiers;

a switch conduction control circuit with two outputs having substantially symmetrical waveforms shifted by about 180 degrees for controlling the conduction of said primary controllable power switches and said first and second synchronous rectifiers; and

a drive transformer used for providing necessary delays between conductions of said primary controllable power switches and said first and second synchronous rectifiers as well as providing power for controlling said primary controllable power switches and said first and second synchronous rectifiers, said drive transformer providing isolation between said primary switch control circuits and said synchronous rectifier control circuits, and said drive transformer comprising:

a first drive transformer winding connected to said switch conduction control circuit;

a second drive transformer winding connected to said first primary switch control circuit, said second drive transformer winding controlling the conduction of said first primary controllable power switch; and

a third drive transformer winding connected to said fourth primary switch control circuit, said third drive transformer winding controlling the conduction of said fourth primary controllable power switch.

2. The power converter recited in claim 1, and further comprising a fourth drive transformer winding connected to said synchronous rectifier control circuit, said fourth drive transformer winding controlling the conduction of said synchronous rectifier.

3. The power converter recited in claim 1, wherein said switch conduction control circuit is also connected to one end of said input voltage.

4. The power converter recited in claim 2, wherein said second and said third drive transformer windings further comprise leakage inductances associated with said drive transformer windings, said leakage inductances being carefully selected and designed in order to achieve optimum delay in turning-on said first and said fourth primary controllable power switches.

5. The power converter recited in claim 1, wherein said second and said third primary switch controls are connected to said switch conduction control circuit through a first and a second inductor, said first and said second inductors being selected to have inductances close to said leakage inductances associated with said second and said third drive transformer windings.

6. The power converter recited in claim 2, further comprising a fifth drive transformer winding connected to said second and said third primary switch control circuits, said fifth drive transformer winding having a leakage inductance carefully selected and designed in order to achieve optimum delay in turning-on said second and

said third primary controllable power switch, said inductances associated with said fifth drive transformer selected to match the leakage inductances of said second and said third drive transformer windings.

7. The power converter recited in claim 1, wherein said each primary switch control circuit further comprises:

at least one controllable switch connected across the control terminals of said primary controllable power switch, said controllable switch being configured to effectively control and provide turn-off of said primary controllable power switch sufficiently quickly to prevent cross conduction of said primary controllable power switches in case of near equal conduction times; and

a diode configured to control and provide turn-on of said primary controllable power switch and to control and provide turn-on of said controllable switch.

8. The power converter recited in claim 7, wherein said at least one controllable switch is physically located close to said first and second primary controllable power switches to enhance turn-off of said primary controllable power switches.

9. The power converter recited in claim 2, wherein each said synchronous rectifier control circuit further comprises:

at least one two input logic circuit to control conduction of each said synchronous rectifier with relatively small input capacitance so that the leakage inductance of said fourth transformer winding does not adversely affect the delay in turning off said

synchronous rectifier, wherein one input of said two input logic circuit is connected to one end of said drive transformer winding connected to said synchronous rectifier control circuit, and the second input of said two input logic circuit is connected to the corresponding synchronous rectifier in order to prevent turning-on of said synchronous rectifier before voltage across said synchronous rectifier drops to a predetermined value; and

a driver circuit connected to said each synchronous rectifier providing optimum turn-on of said synchronous rectifier and providing optimum turn-off of said synchronous rectifier with minimum delay.

10. The power converter recited in claim 9, wherein said two input logic circuit comprises protective diodes on each of said two inputs in order to selectively provide negative and positive voltage greater than supply voltage to be applied across each said input of said two input logic circuit.

11. The power converter recited in claim 10, wherein said two input logic circuit has series resistors in each of said two inputs in order to limit current in said protective diodes whenever negative or positive voltage greater than supply voltage is applied across each said input of said two input logic circuit.

12. The power converter recited in claim 2, wherein said switch conduction control circuit is referenced to said output of said power isolation transformer.

13. The power converter recited in claim 3, further comprising means for disabling the power converter on the input side and thus also the output side from a condition sensed on the output side.

14. The power converter recited in claim 3, and further comprising means for enabling the power converter on the input side from a condition sensed on the output side.

15. The power converter recited in claim 12, further comprising means to disable the switch-mode power converter from the output side of said switch-mode power converter in response to a condition sensed on the input side of said switch-mode power converter.

16. A switch-mode power converter for converting an input voltage from an input source to an output voltage for supply to a load, the power converter comprising:

a power isolation transformer having a primary winding and a second secondary winding;

a primary converter circuit employing full bridge topography comprising a first, and a second primary controllable power switch forming one leg of said full-bridge and a third and a fourth primary controllable power switch forming a second leg of said full-bridge, said first and said fourth primary controllable power switch being connected to the positive side of the input voltage and said second and said third primary controllable power switch being connected to negative side of input voltage, each said leg of said full

bridge being connected to said primary winding of said power transformer for alternatively supplying the input voltage to said primary winding of said power isolation transformer to produce a substantially symmetrical current in said primary winding;

a full wave secondary converter circuit fully isolated from said primary converter circuit and comprising first and a second synchronous rectifiers, said synchronous rectifiers being individually switchable and each being connected between a respective end of said first and second secondary windings and the load;

a first, a second, a third and a fourth primary switch control circuit controlling the conduction of said first, second, third and fourth primary controllable power switches;

a synchronous rectifier control circuit controlling conduction of said each first and second synchronous rectifiers;

a switch conduction control circuit with two outputs having substantially symmetrical waveforms shifted by about 180 degrees for controlling the conduction of said primary controllable power switches and said first and second synchronous rectifiers; and

a drive transformer used for providing necessary delays between conductions of said primary controllable power switches and said first and second synchronous rectifiers as well as providing power for controlling said primary controllable power switches and said first and second synchronous rectifiers, said drive transformer providing isolation between said primary switch control circuits and said synchronous rectifier control circuits, and said drive transformer comprising:

a first drive transformer winding connected to said switch conduction control circuit;

a second drive transformer winding connected to said first primary switch control circuit, said second drive transformer winding controlling the conduction of said first primary controllable power switch; and

a third drive transformer winding connected to said fourth primary switch control circuit, said third drive transformer winding controlling the conduction of said fourth primary controllable power switch.

17. The power converter recited in claim 16, and further comprising a fourth drive transformer winding connected to said synchronous rectifier control circuits, said fourth drive transformer winding controlling the conduction of said synchronous rectifier.

18. The power converter recited in claim 16, wherein said switch conduction control circuit is also connected to one end of said input voltage.

19. The power converter recited in claim 18, wherein said second and said third drive transformer windings further comprise leakage inductances associated with said drive transformer windings, said leakage inductances being carefully selected and designed in order to achieve optimum delay in turning-on said first and said fourth primary controllable power switches.

20. The power converter recited in claim 16, wherein said second and said third primary switch controls are connected to said switch conduction control circuit through a first and a second inductor, said first and said second inductors being selected to have inductances close to said leakage inductances associated with said second and said third drive transformer windings.

21. The power converter recited in claim 17, further comprising a fifth drive transformer winding connected to said second and said third primary switch control circuits, said fifth drive transformer winding having a leakage inductance carefully selected and designed in order to achieve optimum delay in turning-on said second and said third primary controllable power switch, said inductance associated with said fifth drive transformer winding selected to match the leakage inductances of said second and said third drive transformer windings.

22. The power converter recited in claim 16, wherein said each primary switch control circuit further comprises:

at least one controllable switch connected across the control terminals of said primary controllable power switch, said controllable switch being configured to effectively control and provide turn-off of said primary controllable power switch sufficiently quickly to prevent cross conduction of said primary controllable power switches in case of near equal conduction times; and

a diode configured to control and provide turn-on of said primary controllable power switch and to control and provide turn-on of said controllable switch.

23. The power converter recited in claim 22, wherein said at least one controllable switch is physically located close to said first and second primary controllable power switches to enhance turn-off of said primary controllable power switches.

24. The power converter recited in claim 17, wherein each said synchronous rectifier control circuit further comprises:

at least one two input logic circuit to control conduction of each said synchronous rectifier with relatively small input capacitance so that the leakage inductance of said fourth transformer winding does not adversely affect the delay in turning off said synchronous rectifier, wherein one input of said two input logic circuit is connected to one end of said drive transformer winding connected to said synchronous rectifier control circuit, and the second input of said two input logic circuit is connected to the corresponding synchronous rectifier in order to prevent turning-on of said synchronous rectifier before voltage across said synchronous rectifier drops to a predetermined value; and

a driver circuit connected to each said synchronous rectifier providing optimum turn-on of said synchronous rectifier and providing optimum turn-off of said synchronous rectifier with minimum delay.

25. The power converter recited in claim 24, wherein said two input logic circuit comprises protective diodes on each of said two inputs in order to selectively provide

negative and positive voltage greater than supply voltage to be applied across each said input of said two input logic circuit.

26. The power converter recited in claim 25, wherein said two input logic circuit has series resistors in each of said two inputs in order to limit current in said protective diodes whenever negative or positive voltage greater than supply voltage is applied across each said input of said two input logic circuit.

27. The power converter recited in claim 17, wherein said switch conduction control circuit is referenced to said output of said power isolation transformer.

28. The power converter recited in claim 18, further comprising means for disabling the power converter on the input side and thus also the output side from a condition sensed on the output side.

29. The power converter recited in claim 18, and further comprising means for enabling the power converter on the input side from a condition sensed on the output side.

30. The power converter recited in claim 27, further comprising means to disable the switch-mode power converter from the output side of said switch-mode power converter in response to a condition sensed on the input side of said switch-mode power converter.

31. A method of converting an input voltage from an input power source to an output voltage to supply to a load employing a circuit having a power isolation transformer having a primary winding, a drive transformer, primary controllable power switches, synchronous rectifiers, and controllable switches, the method comprising the steps of:

converting power from one form to another form using the power isolation transformer;

isolating the input power from the output voltage;

alternating the conduction of the primary controllable power switches for alternatively supplying the input voltage to said primary winding of said power isolation transformer to transfer energy from the input to the output;

alternating the conduction of synchronous rectifiers to rectify and provide dc output voltage;

supplying power to said primary controllable power switches and said synchronous rectifiers;

cycling said primary controllable switches on and off;

delaying the turn-on of said primary controllable power switches using the leakage inductances associated with the windings of said drive transformer and the input capacitance of the primary controllable power switches;

delaying the turn-on of said synchronous rectifiers until sensed voltage across said synchronous rectifiers drops to a predetermined value;

ensuring minimum delay in turn-off of said primary controllable power switches so that the switching delay of said controllable switch is not affected by the leakage

inductance of associated drive transformer winding, thereby allowing fast turn-off of said primary controllable power switch connected to a drive transformer winding; and

ensuring minimum delay in turn-off of said synchronous rectifiers so that the switching delays are not affected by the leakage inductance of the associated drive transformer winding connected to said synchronous rectifier control circuits.

32. The method recited in claim 31, and further comprising the step of powering and controlling said drive transformer and associated circuits using a switch conduction control circuit.

33. A method for disabling a switch-mode power converter having a drive transformer winding connected to a switch conduction control circuit and a said switch conduction control circuit referenced to the input of the power converter from a condition sensed on the output of the power converter, the method comprising the steps of:

sensing a condition on the output of the power converter that requires the power converter to be disabled;

shorting a drive transformer winding connected to circuitry referenced to the output side of the power converter;

detecting excessive current across a drive transformer winding connected to said switch conduction control circuit connected to the input side of the power converter; and

sending a signal to disable the switch conduction control circuit, thus disabling the converter.

34. A method for disabling a switch-mode power converter having a drive transformer and a switch conduction control circuit referenced to the output of the power converter from a condition sensed on the input of the power converter, the method comprising the steps of:

sensing a condition on the input of the power converter that requires the power converter to be disabled;

shorting a drive transformer winding connected to circuitry referenced to the input side of the power converter;

detecting excessive current across a drive transformer winding connected to the switch conduction control circuit connected to the output side of the power converter; and

sending a signal to disable the switch conduction control circuit, and thus disabling the converter.